Met Office

NEWS

World's oceans capturing unrelenting climate change

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The world's oceans are charting the unrelenting progress of climate change says a new global report: The State of the Climate in 2021.

The 32nd annual State of the Climate report – published today by the Bulletin of the American Meteorological Society – shows that two marine-related measures – ocean heat content and global sea level rise – were the highest on record last year.

Scientists measure climate change by a number of different means. Measuring the Earth's surface temperature is the most familiar method and is the one linked to global action on climate change, such as the Paris Agreement.

The Met Office's Dr Robert Dunn has been the lead editor of the report's Global Climate chapter for several years. Commenting on this year's report he said: "By measuring Earth's surface temperature since 1850 we know that 2021 was one of the six hottest years since records began. However, natural variations including planetary cycles – such as the temporary cooling of the tropical Pacific during the recent La Niña event – can mask some of the detail of climate change when using only the surface temperature as a metric.

"But when you look at how much the deep ocean is warming and how much sea levels are rising it is easier to obtain a clearer trend of ongoing climate change, as the majority of the excess energy trapped in the climate system by increases in greenhouse gases goes into heating the oceans. For these two measurements 2021 was a record-breaking year."

Ocean heat content and sea level rise are important components of the climate system. The ocean has the largest heat capacity on earth and more than 90% of the extra heat goes into increasing ocean heat content. Sea level rise – led by the thermal expansion of water and melting glaciers and ice caps – is an important consequence of climate change.

Robert Dunn concluded: "The evidence of climate change becomes more stark with the publication of every annual State of the Climate report. If we can get to a point where atmospheric greenhouse gas concentrations start to flatline or even reduce, we would in time start to see a much more positive picture of our climate and our future from these reports."

The State of the Climate report details:

- **Ocean heat content**
  The ocean stores about 91% of the energy gained by Earth's climate system over the past half century. Global ocean heat content – measured from the surface to a depth of more than 2000 metres – continued to increase and reached new record highs in 2021.

- **Sea level rise**
  For the 10th consecutive year, global average sea level rose to a new record high and was about 97mm higher than the average for 1993 – when the satellite measuring record began.

- **Earth's warming trend**
  2021 was the fifth, sixth or sixth-equal warmest year since 1850 depending on the dataset. The last seven years (2015-2021) were the seven warmest years on record. La Niña conditions that began in mid-2020 continued for most of last year. La Niña is part of the El Niño Southern Oscillation (ENSO) cycle of natural variation in the tropical Pacific. La Niña events cool global temperatures by about a fifth of a degree C. The annual global average sea surface temperature in 2021 was lower than both 2019 and 2020 due in part to La Niña but still 0.29C higher than the 1991-2020 average. As a result of these higher-than-average temperatures, approximately 57% of the ocean surface experienced at least one marine heatwave.

- **Greenhouse gases highest on record**
  The atmospheric concentrations of the three major greenhouse gases (carbon-dioxide, methane and nitrous oxide) all rose to new record values in 2021. The rate of increase of methane concentrations was the highest since records began in the early 1980s.

- **Arctic**
  The Arctic had its coolest year since 2013, but 2021 was still the thirteenth warmest in the 122-year record.

The State of the Climate report is a peer-reviewed series published annually as a special supplement to the Bulletin of the American Meteorological Society. It is available online here.

The Met Office also tracks key global climate indicators on its Global Climate Dashboard.

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